COMPUTER-AIDED SYSTEMS AND TECHNOLOGIES IN AGRICULTURE

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Abstract: *Scientific grounds and computer-aided systems for estimation and selection of technologies with due account for natural and economic conditions of the farms have been developed. Estimation criteria are minimal energy, labor and money inputs, as well as environmental considerations. Computer-aided systems allow calculating the flow process charts, to optimize the machine and tractor fleet and material support of technologies.*
Key words: *farming technology, set of machines, computer-aided system, estimation criterion, mathematical model, optimization*

INTRODUCTION

Russian farming is gradually getting over the crisis of the 90-ies. In 2005 agricultural production demonstrated 2% growth over the level of the year 2004. For the first time in recent 15 years the Government of Russia is placing special emphasis on this sector, listing it in the top priority national programs. The amount of governmental grants in agriculture is expected to be around USD 2,5 thousand million, that is, however, 10-fold less compared to the United States, and 24 times less than in Europe [1].

In Russia there currently function big agricultural enterprises, production and economic performance of which is up to the world standards. For example, the dairy herd in “Rabititsy” farm in Leningrad Region is around 1000 head with the annual milk yield of 9022 kg per cow, grain yield of 4,5 t/ha, and potato yield of 30 t/ha [2].

The positive trends in nowadays farming result mainly from introduction of technological innovations. One of the innovative (know-how) activities is the transfer to integrated farming technologies based on technical upgrading (re-equipment) of farming.

1. Computer-aided estimation and choice of technologies.

Elaboration of scientific grounds and computer-based systems for the development of technologies, which are customized for various natural environments, farm sizes and investment opportunities, is one of priority activities of the North-West Research Institute of Agricultural Engineering and Electrification (SZNIIMESH).

The principles of this process are shown on Fig.1.

These technologies are developed and introduced on the basis of scientifically grounded and integrated systems of cropping and livestock management for natural and economic zones, regions and separate farms. Each hierarchy level has its own customizing factors, the due account for which ensured the utmost economic returns per unit of nonrenewable resources, capital and labor inputs.

Technology formation (development) process is formalized for the on-line mode to be applied, which combines the PC vast computing power with the expertise of the operator in charge.

Technology formation method includes the following stages: general algorithm development; substantiation of optimization criteria; creation of databases on technological processes, machines, equipment, energy consumption standards, labor inputs, etc.; creation of the system of mathematical models for estimation and improvement of performance of separate machines and the technology as a whole; required farm data acquisition and processing.

The key stage is to form the technology tailored to the conditions of a particular farm or typical zonal or regional conditions, and to analyze the obtained results.

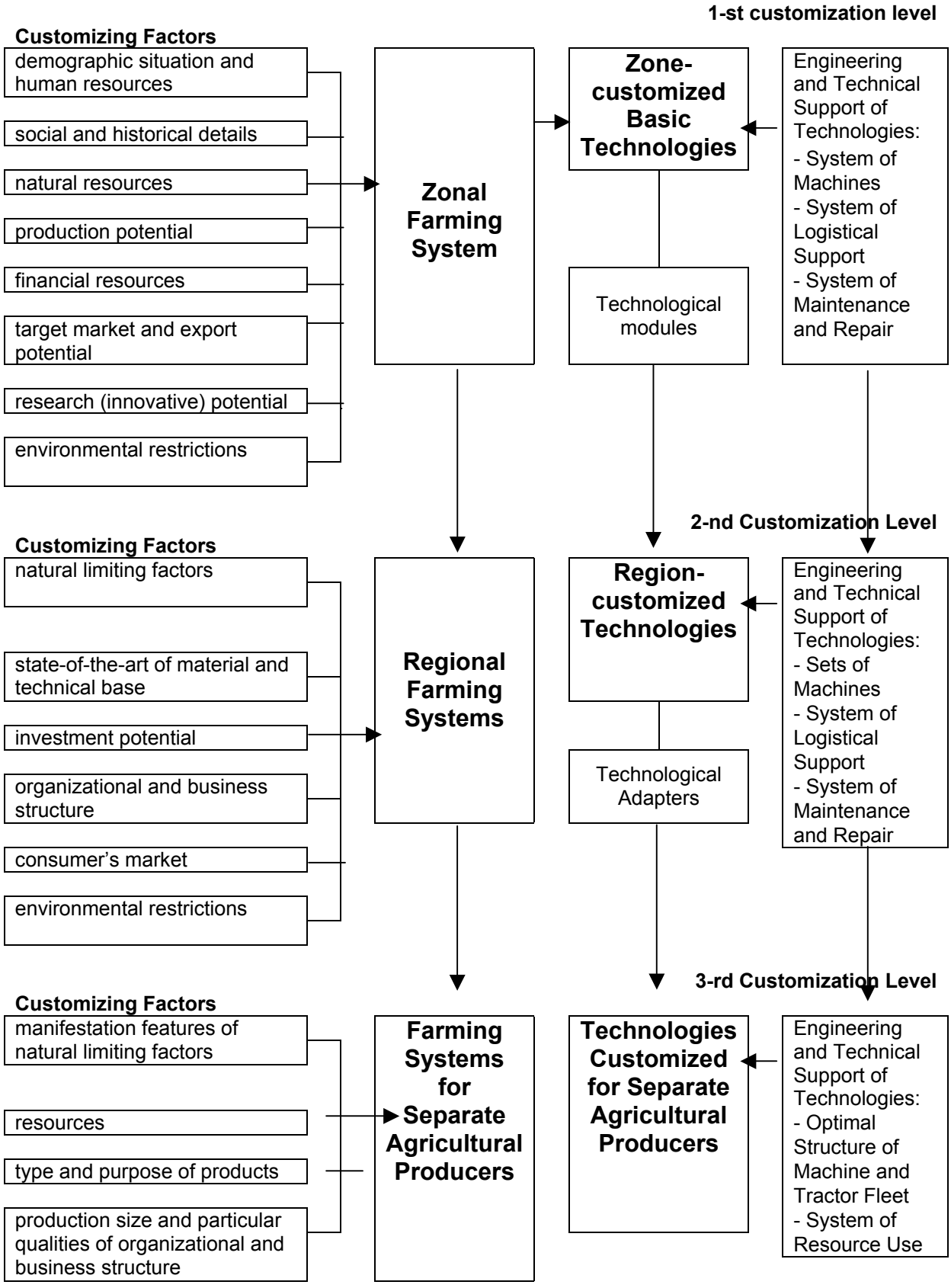


Figure 1. Formation principles of customized technologies for present-day farming

Generalized criterion $K_{об}$ is applied in the optimization process, which, depending upon the task, may be the minimal unit costs in roubles or energy inputs in kJ.

$$K_{ОБ} = \sum K_I \lambda_I \rightarrow \min \qquad (1)$$

where λ is a weighing factor to convert K_i criteria to unified dimensionality;

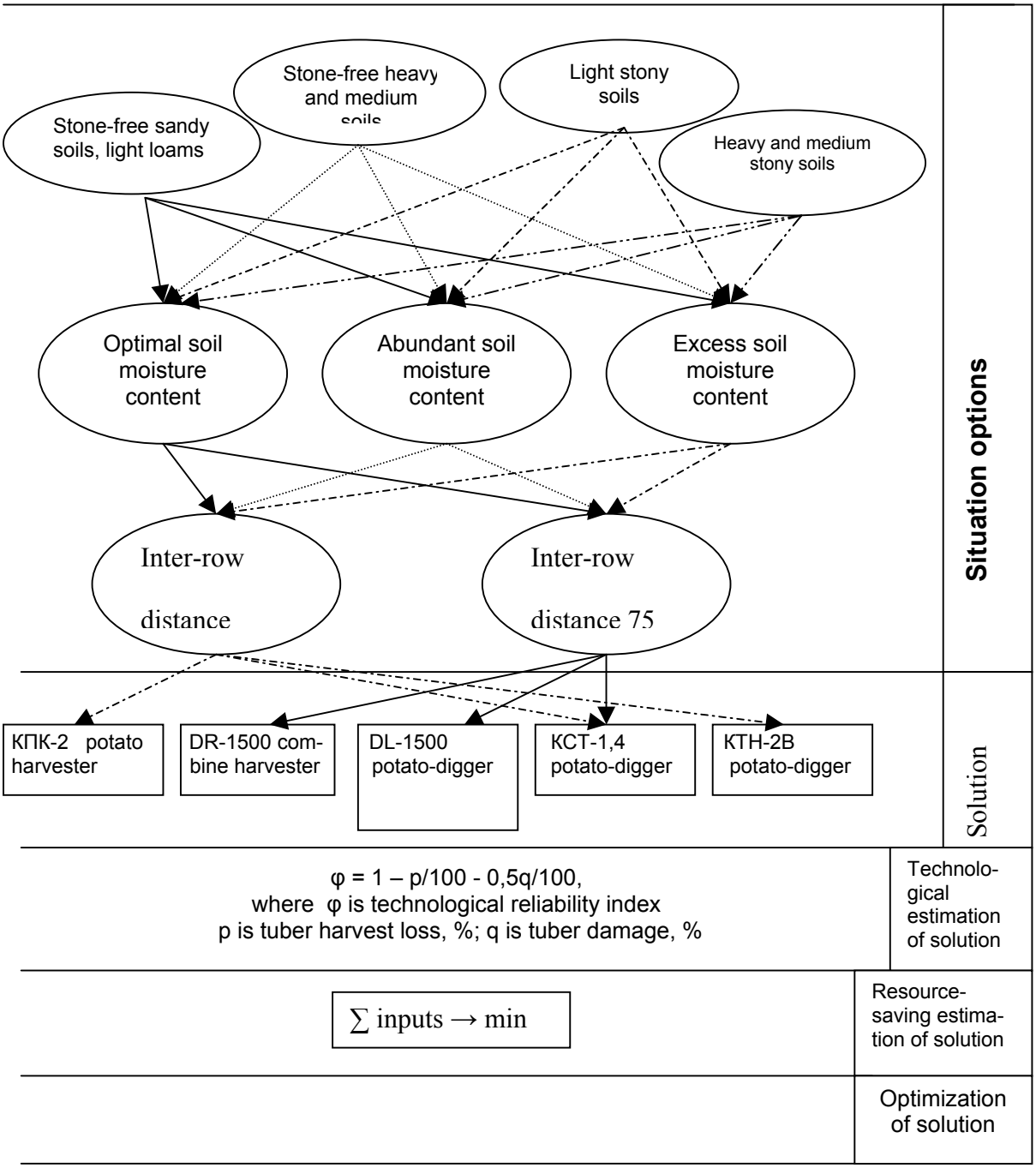
K_i are separate estimation criteria: labor, power, material inputs, and operating expenses.

Some other criteria may be applied by the client's request.

Environmental safety indices and benefit-giving qualities of products are the key restricting factors when describing and fulfilling the task.

Mathematical production models of various plant and animal products differ owing to the specific features of technological processes.

Fig.2 presents the optimization model of potato harvesting.



$$E = \frac{\sum inputs}{\varphi} \rightarrow \min$$

Figure 2. Optimization model of potato harvesting

Based on the created in the institute algorithms, databases, mathematical models and computer programs, the automated work stations have been designed for technological experts, which allow developing the technologies for potato, vegetables, fodder, grain, milk and meat production.

Computer-aided systems are applied to calculate the flow process charts of the technologies, which are most efficient for a particular farm, the optimal machine and tractor fleet and the payback period when introducing these technologies. For example, introduction of the customized technologies of potato growing on the farms in Leningrad and Kaliningrad Regions resulted in 25% bigger potato yield and 40% lower prime cost (as low as 2,5 Roubles per kilogram).

2. Development of basic technologies.

The basic technologies with different intensity level have been developed for typical conditions of the North-West Region of Russia, which provide profitable farming in the enterprises with various investment opportunities. The basic technologies are integrated in the Regional System of Technologies and Machines, and serve as recommendations for farm managers when purchasing new machines and introducing new techniques.

Analysis of the basic technologies allows defining the most cost-intensive technological operations and to substantiate the parameters of new machines required to secure the effectiveness of the technology as a whole. Some of these machines, which will have characteristics tailored to the zonal conditions, are under development at the institute.

3. Introduction of computer programs.

The computer programs designed by the institute experts to aid the development of mechanized technologies for farm production of selected agro-products (grain, fodder, potato, milk, pork), which are best adjusted to climatic and economic conditions of a farm, are widely applied by the farmers and other agricultural producers when reconstructing existing farms or building new ones. Above 40 dairy and pig farms, and 5 potato and vegetable farms have been reconstructed in Leningrad Oblast of Russia for the last two years.

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